Canadian Organization for Tropical Education & Rainforest Conservation


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Submitted to:
MINAET (Costa Rican Ministry of Environment, Energy and Telecommunications)
COTERC (Canadian Organization for Tropical Research and Rainforest Conservation)

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MANY THANKS TO THE FOLLOWING ORGANIZATIONS FOR THEIR CONTINUED SUPPORT OF THE PROJECT:
ACKNOWLEDGEMENTS

The 2012 season of the COTERC Marine Turtle Monitoring & Conservation Project was conducted under a permit from the Ministry of Environment, Energy and Telecommunications (MINAET) of Costa Rica.

The Donner Foundation in Canada has continued to financially support this Project which has enabled us to to monitor and protect marine turtles and their nesting habitat on Playa Norte. Extended gratitude goes to Vista al Mar Lodge for allowing the project’s participants to access Playa Norte via their property as well as Turtle Beach Lodge for use of their facilities.

Data in this report was collected by many staff, students and volunteers. The success of the 2012 season would not have been possible without each individual’s devotion to sea turtle conservation expressed by their sincerity and tireless work efforts. Many thanks in particular to York University Interns Kirstin Silvera, Sarah Bradley, Shenique Turner and Mariya Cheryomina and University of Applied Sciences HAS Den Bosch students Jasper Buijs, Mark Groen, and Ilse Leemans. All of these students acted as patrol leaders for three to five months and were absolutely essential to the project. Having long term students makes the Project possible. Our gratitude also goes to Station Managers, Charlotte Foale and Manuel Arias for supporting the Project, scheduling volunteers and spending many long hours on the beach. Thank you also to Emma Lehmberg, Ilse Leemans, Anjolene Hunt, Geoff Gould, Sophia Meritt and Rhianna Boyle for their assistance in data sorting and analysis.

Gratitude is also extended to the Sea Turtle Conservancy (STC) and Dr. Emma Harrison for their continued support, friendship and assistance with training. Also a huge thank you to the villagers of San Francisco for all of their help and continued interest in working with COTERC and Caño Palma Biological station staff and volunteers.

Thank you for the continued support of the project by COTERC members and board.
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SUMMARY

- A total of 455 surveys amounting to 1866 miles were conducted during the 2012 turtle season up to October 15th, which monitors green turtles (*Chelonia mydas*), hawksbill turtles (*Eretmochelys imbricata*), loggerhead turtles (*Caretta caretta*).
- First nesting green turtle track was found on May 3rd. The first nesting hawksbill turtle track was found on April 13th. The first nesting loggerhead turtle female track was found on April 30th.
- Last nesting green turtle was encountered on October 23rd and the last tracks found on November 15th. The last nesting hawksbill was encountered on October 11th and the last tracks on October 25th, the last nesting loggerhead was encountered on August 25th.
- 2321 green turtle tracks were recorded in the 2012 season. 32% (n=735) of all emergences resulted in eggs laid, while 67% (n=1560) of all emergences were false crawls.
- 92 Hawksbill turtle tracks were recorded in the 2012 season. 34% (n=40) of all emergences resulted in eggs laid, while 54% (n=50) of all emergences were false crawls.
- 36 loggerhead turtle tracks were recorded in the 2012 season. 28% (n=10) of all emergences resulted in eggs laid, while 72% (n=26) of all emergences were false crawls.
- The majority of green, hawksbill and loggerhead nests were found in the border area with 69%, 64%, and 60% of all nests respectively.
- The peak of the green turtle season occurred the week of August 12th with a total of 124 nests and 446 tracks overall. The peak nesting day was August 17th with 41 nests and 154 total tracks.
- The peak of the hawksbill turtle season occurred the week of August 5th with a total of 5 nests and 10 tracks overall.
- The highest number of green turtle nests were laid between 0.25 and 0.38 miles with 69 nests.
- The highest number of hawksbill turtle nests were laid between 2.13 and 2.25 miles with 4 nests.
- Green turtles were encountered on 299 instances during night patrol. From these 166 individuals were identified by flipper tags. 32 green turtles were encountered more than once.
46% (n=77) of green turtles identified by flipper tags already had tags or showed signs of previous tagging, whereas 54% (n=89) were likely tagged for the first time, having no signs of old tag holes or tag notches.

All green turtle encounters occurred between 20:00 and 04:00, with most encounters, 14% (n=42), between 00:01 and 00:30.

Hawksbill turtles were encountered on 17 instances during night patrol. From these 9 individuals were identified with flipper tags. Two turtles were encountered twice.

33% (n=3) of hawksbill turtles identified by tags already had tags or showed signs of previous tagging, whereas 64% (n=6) were likely tagged for the first time, having no signs of old tag holes or tag notches.

Mean green turtle CCL\text{min} was 105.6 cm (SD 4.77) with a maximum of 120.5 and minimum of 91.5. Mean CCW\text{max} was 94.9 cm (SD 4.67) with a maximum of 106.6 and minimum of 84.0.

Mean hawksbill turtle CCL\text{min} was 87.97 cm (SD 4.85) with a maximum of 97.27 and minimum of 84.07. Mean CCW\text{max} was 79.3 cm (SD 6.18) with a maximum of 90.43 and minimum of 71.90. Several hawksbill turtle encounters were covered in barnacles that may have affected measurements.

55% (n=395) of all green turtle nests checked during morning census were determined to be in natural condition, 39% (n=275) were classified as unknown, 6% (n=42) of nests were determined to have been poached in the first two days after being laid.

Overall 42 green turtle nests were recorded as poached during morning census. All poached nests, as determined by morning census, occurred between June 24\textsuperscript{th} and September 29\textsuperscript{th}.

72% (n=28) of all hawksbill nests checked during morning census were determined to be in natural condition, 23% (n=9) were classified as unknown, 5% (n=2) of nests were determined to have been poached in the first two days after being laid.

78% (n=7) of all loggerhead nests checked were determined to be in natural condition, 22% (n=2) were classified as unknown, 0% (n=2) of nests were determined to have been poached in the first two days after being laid.

28 turtles were either found deceased or lifted on Playa Norte in 2012. 26 were green turtles and 2 were hawksbill turtles.

One green turtle was found flipped upon morning census. The turtle was flipped back over and safely returned to the sea.

All human survey activities, except the number of fires, increased through the season reaching a peak in July and then declined.
705 people were seen on night patrol, 332 were identified as locals and 373 as tourists.

**INTRODUCTION**

Although Caño Palma Biological Station is in its 21st year (est. 1991) and marine turtle research has a very long history in the Tortuguero area, it was not until 2004 that the Canadian Organization for Tropical Education and Rainforest Conservation (COTERC) became directly involved in sea turtle conservation. Initially approached, and subsequently assisted by, the Sea Turtle Conservancy (STC)\(^1\), a feasibility study was conducted in the 2004 and 2005 nesting seasons. From this initial investigation, consisting solely of morning track counts, it was determined that the four species of marine turtles: *Chelonia mydas*, *Dermochelys coriacea*, *Eretmochelys imbricata*, *Caretta caretta*; that utilize Playa Norte as a rookery did indeed nest in high enough numbers to warrant long-term investigation. Thus, the COTERC Marine Turtle Monitoring and Conservation Project has been running annually by MINEAT permit since 2006.

As the majority of nesting females emerge at night, night patrols are necessary to observe their behavior and obtain biometric data on these individuals. With the exception of Leatherbacks and random injury or abnormalities, sea turtles lack external morphological differences that identify them as individuals. Leatherbacks have “pink spots” on their heads which have proven to be unique; however, documenting the spot would require photography permits which the Project currently does not have. Therefore, it is necessary to flipper tag\(^2\) all species of turtles which allows for positive identification and monitoring of individual females. Thus in 2006, a more vigorous monitoring program was initiated that included night surveys during which flipper tagging was conducted. Further additions to the Project during 2006 included nest excavations and nest relocations. Excavations allow the project to assess habitat productivity and potentially, individual reproductive success rates.

The combined aspects of the monitoring project provide critical data on individual’s health and their reproductive output, as well as population dynamics, minimum recruitment and the viability of the nesting beach habitat. These factors have made the COTERC Marine Turtle Monitoring and Conservation Program a robust and sound contributor to the management plan of the Barra del Colorado Wildlife Refuge part of the Area of Conservation Tortuguero (ACTo). It also contributes towards a better understanding of the larger meta-population dynamics for sea turtles in the Tortuguero area.

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1. Sea Turtle Conservancy was formerly known as the Caribbean Conservation Corporation (CCC).

2. Refer to methods for tagging procedures.
Documented within this report are the methodologies, results, and a brief discussion of the 2012 Green, Hawksbill, and Loggerhead seasons. A separate technical report documents the 2012 Leatherback season. The data for nesting female sea turtles in the main body of this report takes into account nests laid up to October 15th due to the completion of the Head Interns contract on October 31st. Night Patrols continued until November 15th with a further 36 green turtles nesting and two hawksbill turtles. Excavations continued until December 31st.

METHODS

Protocols used throughout the 2012 season follow guidelines set out by the IUCN/SSC Marine Turtle Specialist Group as well as those used by the STC. For further details, please refer to the 2010 Marine Turtle Monitoring and Conservation Program Night, Morning and Excavation Protocols (http://www.coterc.org/?page_id=194).

Study Site: Playa Norte

The study site, known as Playa Norte, is located within the Barra del Colorado Wildlife Refuge (BCWR), a protected area of wet Atlantic lowland rainforest on the north east Caribbean coast of Costa Rica. The BCWR is managed by the Tortuguero Conservation Area (ACTo) and is regulated by the Costa Rican Ministry of Environment, Energy and Telecommunications (MINAET). The study site is a 3.125 mile (approx. 5 Km,) stretch of beach that runs from the Tortuguero River Mouth (10º35’34.4”N - 83º31’28.6”W) to the north end of Laguna Cuatro (10º38’06.9”N - 83º32’31.7”W, see Figure 1). Laguna Cuatro is a large lagoon which occasionally floods and disconnects the last 0.125 of a mile of the transect during the early and later months of the year. Final determination for spatial analysis was determined by northern GPS units (dd hh mm.s) to ensure accuracy. Permanent structures on Playa Norte consist of two lodges; Turtle Beach Lodge and Vista al Mar Lodge, and several houses. Additionally, a path used by those on foot, bicycle, horseback or car, runs parallel to the beach. Monitoring of the study site and its use by people is conducted throughout all four species nesting seasons (see Table 1).

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<tr>
<th>Species Name</th>
<th>Common Name</th>
<th>Peak Nesting Season</th>
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</thead>
<tbody>
<tr>
<td>Chelonia mydas</td>
<td>Green</td>
<td>June to October</td>
</tr>
<tr>
<td>Dermochelys coriacea</td>
<td>Leatherback</td>
<td>March to June</td>
</tr>
<tr>
<td>Eretmochelys imbricata</td>
<td>Hawksbill</td>
<td>April to September</td>
</tr>
<tr>
<td>Caretta caretta</td>
<td>Loggerhead</td>
<td>April to September</td>
</tr>
</tbody>
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Training of Project Participants

Patrol leaders (PLs) and volunteers were trained upon their arrival at Caño Palma Biological Station. All Patrol Leaders were trained by the Head Intern, with help from long term interns, and tested both by written and situational formats prior to becoming a full PL. Pass rates were set at 95% and upon completion, were thoroughly discussed. In the case where this standard was not met, people were given the opportunity to retake a smaller version of the test made up of questions they missed. They were again required to pass at 95%. Training for all project participants (PLs included) was conducted first in the classroom, followed by practical in-field preparation in order to ensure proficient data collection and ethical behavior on the beach.

Classroom training consisted of lectures on marine turtle biology and conservation, project protocols and included discussions of possible beach scenarios. Practical training included triangulation and reverse triangulation techniques and PLs received practical tagging training using dummy flippers (cardboard). Finally, all potential PLs were accompanied by the Head Intern or an experienced long-term intern on both morning and night patrols until they were considered able to lead patrols independently.
Morning Census and Nest Status Assessments

Track surveys were conducted daily. Surveys typically started between sunrise and 6am. Encountered tracks were categorized as **Half-moons (HLF)**: non-nesting emergences, **Nests (NST)**: emergence resulting in a clutch), or a **Lift (LIF)**: track abruptly ends due to turtle being lifted and removed from the beach by poachers). For each of these categories the following information was also collected:

- Date
- Global Positioning System (GPS) location and instrument accuracy
- Species
- Closest northern mile marker (for spatial analysis)
- Vertical position³
  - **Open (O)**: area of beach which receives 100% sunlight
  - **Border (B)**: area where nest is partially shaded by vegetation
  - **Vegetation (V)**: area where nest is constantly shaded by vegetation.

![Figure 2 Vertical position of nests: V= Vegetation, B= Border, O= Open](image)

For **HLFs** vertical position was the most westward point on the animal’s track (Figure 3). For **NSTs**, vertical position was where the eggs were believed to be, as determined from the disturbed sand and track directions.

³ Relates to the amount of sunlight a nest will receive not actual vegetation composition
If the emergence event resulted in eggs being laid, the nest was further classified as one of the following:

- **Natural:** appeared undisturbed and in its original state
- **Poached:** when egg shells *and* a cavity were found
- **Eroded:** tidal/wave action of sea eroded the beach and eggs washed out or left exposed
- **Predated:** disturbed/destroyed by an animal.
- **Unknown:** signs of human disturbance such as stick holes, disturbed sand, cavities and human and/or dog prints; however, no conclusive evidence (egg shells *and* cavity) were present.

Once data collection was complete, all tracks and nests were disguised to prevent double counting as well as confuse any possible future poaching efforts. Furthermore, all nests were investigated for two consecutive mornings to document possible poaching activities.

All nests, beginning 60 days after laid, were monitored during morning census for signs of hatching. Observed hatchling tracks were traced back to the common volcano, two sticks placed on either side of the depression for identification for later excavation (see Incubation Duration and Nest Success) and the following information recorded:

- Date
- GPS location and instrument accuracy
- Closest northern mile marker
- Nest number (if believed to be a triangulated nest)
- Any dead or alive hatchlings found outside of the nest
- Any egg shells found outside the nest

**Night Patrols**

Each night, a minimum of one patrol team composed of at least three members, walked the beach between mile 0 and 3.125 for a minimum of four hours. When a turtle track was found, the patrol leader determined whether or not the turtle was still present. If the turtle was not, the patrol leader determined if the track was a HLF, NST or LIF and the team proceeded to collect the following information:

- Date
- GPS location and instrument accuracy
- Species
- Northern mile marker

---

4 Depression made by collapse of chamber when hatchlings emerge
Time of encounter
Vertical position
If deemed a nest, further categorized as Natural, Poached, Eroded, Predated or Unknown

If the turtle was still on the beach, nesting stage was exclusively determined by the Patrol Leader and appropriate action taken relevant to the nesting stage (see Table 2).

Table 2 Patrol activities as they relate to nesting stage of the encountered female

<table>
<thead>
<tr>
<th>Turtle Activities</th>
<th>Patrol Response</th>
</tr>
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<tbody>
<tr>
<td>Emerging from sea</td>
<td>Discreetly wait.</td>
</tr>
<tr>
<td>Selecting nest site</td>
<td>Discreetly wait.</td>
</tr>
<tr>
<td>Digging body pit</td>
<td>Discreetly wait.</td>
</tr>
<tr>
<td>Digging egg chamber</td>
<td>PL and one other team member cautiously approach turtle from behind to prepare for egg counting.</td>
</tr>
<tr>
<td>Oviposition</td>
<td>Egg counter counts eggs visually and by hand (when possible). Other team members begin triangulation of nest to known landmarks.</td>
</tr>
<tr>
<td>Covering egg chamber</td>
<td>Check for tags and/or scarring from lost tags. Apply tags if needed. Obtain biometrics.</td>
</tr>
<tr>
<td>Disguising</td>
<td>Finish data collection and data completion check.</td>
</tr>
<tr>
<td>Returning to sea</td>
<td>Check for tags if possible. Observe.</td>
</tr>
</tbody>
</table>

Egg Counting and Triangulation

A team member previously designated to the role, counted eggs visually and when possible, physically also by holding a latex gloved hand 5-10 cm below the cloaca and feeling eggs drop past. Both yolked and yolkless eggs were counted. Immediately after oviposition was completed, egg depth was recorded. Once the female started to cover the eggs with sand, a small piece of numbered flagging tape was placed in the egg chamber, which facilitates proper nest identification upon its excavation. Triangulation was conducted for all nests encountered during oviposition when possible. One team member stood directly over the chamber to ensure accurate measurements were taken (for triangulation procedures please see Night Protocols on http://www.coterc.org/?page_id=194). When a turtle was encountered covering, triangulation was also conducted under the patrol leader’s discretion and further noted in data.
Tagging and Biometrics

Upon completion of oviposition, flippers were investigated to see if the animal had current tags, or tagging scars. Scarring from previous tagging efforts such as **Old Tag Notches (OTNs)** or **Old Tag Holes (OTHs)** were recorded (see Figure 3).

Biometric data was obtained for tagged individuals. Using a flexible measuring tape, Curved Carapace Length (CCLmin) and Width (CCWmax) were measured three times each, to the nearest millimeter. CCLmin was measured from where the skin meets the carapace behind the head to the end of the caudal projection on the right of the central ridge (Figure 4a). CCWmax was measured from where the carapace meets skin on the widest part of the carapace (Figure 4b). After obtaining biometrics, an assessment of the animal’s external condition was conducted. This included classifying the caudal projection as complete if no abnormalities were observed, or incomplete if part of it was missing. Some, but not all, incomplete abnormalities of the caudal projection prevent

**Figure 3** Diagram of old tag holes and old tag notches (modified from Barragan 1998)
CCLmin measurement. Any injuries, damaged tissue, abnormalities or tumors were also documented.

Figure 4 Proper position of the minimum curved carapace length (CCLmin) and the maximum carapace width (CCWmax) measurements (modified from Bolten, 1999)

**Disguising Adult Emergence Events**

After data collection, all signs of an emergence event were erased or disguised by the first patrol team to discover the event. This was done primarily to diminish the possibility of double counting the nest by later night patrols or morning patrols. Disguising was accomplished by several methods including disturbing a larger area of sand than originally done by the turtle, and dusting the area with a layer of dry sand to hide tracks and nests.

In 2012, another approach was taken to reduce poaching. Noticing poachers usually use a stick to test the density of the sand, subsequently revealing the recently dug egg chamber, patrol teams began to create decoy egg chambers (Figures 5, 6, and 7). This was done in hopes of diverting poacher’s attention from the real nest. Overall decoy egg chambers were dug for 62 nests during the turtle season. Decoy egg chambers were dug more often when the season was less busy as to not take time away from actually encountering turtles. In accordance with this, they were usually dug when the turtle was disguising and the team was finished with data collection. Decoy egg chambers were dug away from the actual nest in either a fake body pit or attempted body pit area. This reduced the likelihood of introducing bacteria into the nest. The number of decoy chambers dug, and the location of the chamber in relation to the real nest (north, south, east or west) was documented to provide for future analysis. This clarification also allowed for morning teams to determine if the real nest or the decoy had stick-holes in them. As the season progressed, more turtles were encountered and
there was less time to continue this process. In addition, erosion led to turtles nesting higher into the vegetation, which made it more difficult to dig chambers by hand.

Figure 5 Volunteers help to dig decoy egg chambers. Many volunteers enjoy the experience as it makes them feel like they are doing something to contribute to conservation and the prevention of poaching.

Figure 6 (Left) Four decoy egg chambers, one made by each member of the patrol team, away from the real nest. (Right) Up close view of decoy egg chamber, made to resemble a natural turtle nest.
Fig. 7 A natural green turtle (C. Mydas) nest and disguise area (A), a decoy disguise area and egg chambers (B), made around the natural body pit (C)

**Incubation Duration and Nest Success**

Incubation duration and nest success was calculated using data from the whole nesting season until the last nest was excavated. Triangulated nests were used to calculate incubation duration and excavation status as data collected from these were the only ones where reliable dates and information on initial clutch sizes were obtained. Other nests that were not triangulated were excavated and information obtained on hatching success and emergence success. Nests were determined hatched if hatchling tracks were observed and traced back to a common “volcano” (refer to morning census). Incubation duration in days was thus determined by taking the date when hatchling tracks were first recorded and counting back to date laid; however, excavation was postponed two days from track observation to reduce disturbance to individuals late to emerge. In the case of triangulated nests that failed (0% success), or evidence of emergence was not observed, the project waited 70 days from the date the eggs were laid to prevent any potential disturbance to developmentally delayed clutches.

For each excavated nest the following information was recorded:

- **Egg Depth (cm)** – Distance between the sand surface to the first shell or egg encountered
- **Nest Depth (cm)** - Distance between the sand surface and the bottom of the egg chamber
- **Number of yolkless eggs**
- **Number of hatched eggs** – Shells ≥ 50% of original size
- **Number of hatchlings in-nest:**
  - Alive
  - Dead

- **Number of un-hatched eggs:**
  - Without embryo
  - With embryo (see Figure 8):
    - **Stage 1** (embryo occupies less than 25% of the egg)
    - **Stage 2** (embryo occupies between 25% and 50% of the egg)
    - **Stage 3** (embryo occupies between 50% and 75% of the egg)
    - **Stage 4** (embryo occupies between 75% and 100% of the egg)

- **Unknown** – Embryo has been predated/destroyed and impossible to determine at what stage development stopped

- **Number of pipped eggs** – hatchling broke through but failed to fully emerge from the shell.

![Embryonic development stages](image)

*Figure 8 Embryonic development stages used during nest excavations (Chacón et al. 2007).*

Any abnormalities, such as twins, albinos and developmental deformities were also documented as well as recording the number of eggs with the presence of larvae bacteria/fungi, ants, crabs or roots. Upon excavation completion, the nest was ultimately categorized as one of the following final nest statuses: **natural & - hatched** or **- un-hatched, poached, predated,** or **eroded.** Nests were only determined as poached if the flagging tape deposited at the time of egg counting was found in an empty chamber. Or, alternatively, only yolkless eggs were present when it had been observed during oviposition that yolked eggs had been laid. Only excavation nest status was used to determine poaching rates and unexcavated nests were excluded from hatching and emergence success analysis. Due to the prevalence of dogs on Playa Norte it was also noted in the comments whether or not a nest had been dug up by dogs prior to the excavation. If this was the case they the subsequent excavation was excluded from the hatching and emergence success analysis.
Hatching and emergence success rates were calculated using methods from Miller (1999) (see Table 3). Hatching success is the number of hatchlings that completely hatch out of their egg shell whereas emergence success refers to the number of hatchlings that successfully exit the chamber to the sand surface (Table 3). Mean success rates were calculated by averaging the success rate of each nest rather than summing overall nest contents and assessing mean success from those values.

Table 3 Definitions and formulas used to determine hatching & emergence success rates as described by Miller (1999) including the equivalent developmental stages used in the project.

<table>
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<td>Shells (S)</td>
<td>Number of empty shells (&gt;50%)</td>
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<td>Live in Nest (L)</td>
<td>Live hatchlings remaining in nest</td>
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<td>Dead in Nest (D)</td>
<td>Dead hatchlings outside of shells</td>
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<td>Undeveloped (UD)</td>
<td>Unhatched eggs with no obvious embryo</td>
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<td>Unhatched (UH)</td>
<td>Unhatched eggs with obvious embryo (S1-S3)</td>
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<td>Unhatched Term (UHT)</td>
<td>Unhatched full term embryo (S4) or Pipped</td>
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<td>(De)predated (P)</td>
<td>Nearly complete shells containing egg residue. Includes shells predated by animals, bacteria fungi and vegetation.</td>
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</table>

Hatching Success (HS%) = \( \frac{\text{#Shells}}{\text{#S} + \text{#UD} + \text{#UH} + \text{#UHT} + \text{#P}} \times 100 \)

Emergence Success (EM%) = \( \frac{\text{#Shells} - (\text{#L} + \text{#D})}{\text{#S} + \text{#UD} + \text{#UH} + \text{#UHT} + \text{#P}} \times 100 \)

**Adult Turtle Poaching**

If dead turtles were encountered during surveys, the following information was recorded:

- Date
- GPS location and accuracy
- Species
- Closest northern mile marker
- CCLmin and CCWmax
- Tag numbers (if present)

Signs of wounds or missing body parts, estimated time since death and condition of the carcass when first found where documented as well. Furthermore, the carcass was photographed (the following morning if originally discovered at night).
Human Presence and Light Source Surveys

The Human Presence and Light Source Surveys, formally known as Human Impact surveys, were conducted throughout each night patrol by all patrol members. Each person was responsible for assisting in tallying the number of people utilizing the beach (in any form, i.e. tourism, commuting, etc.). Each person was also responsible for counting the following sources of non-natural light:

- **Number of mobile red and white lights**: Visible moving lights carried by non-patrol members or headlights of moving vehicles on the beach and parallel path.
- **Number of Fires**: The number of active flames directly on the beach.

Surveys

Overall, 455 surveys were conducted from March 14th until October 14th, accounting for 1866 miles. Intermittent morning patrols and night patrols began on March 14th and March 21st, respectively. Daily morning and night patrols began April 12th when the Project Head Intern began full time. At this time, night patrols occurred every night unless cancelled because of lack of participants or illness of patrol leaders. Morning patrols occurred every morning from April 12th and continued until December 31st for nest excavations. Figure 9 shows the percentage of days of each month covered by morning patrol, one night patrol team (PM1), two night patrol teams (PM2), three night patrol teams (PM3), and four night patrol teams (PM4). In order to increase encounters of turtles during green turtle season, volunteers were recruited and multiple teams were available for nights May through August. Monitoring of other marine turtle species continued through October but data in this report pertains only to that collected prior to October 15th, 2012. Night patrols continued until October 31st. Excavations continued until all hatched nest data had been collected on December 31st. Beach coverage by patrol teams in 2012 shows a significant improvement from 2011. Patrons consisted of the head intern and COTERC staff and volunteers as well as students from various international universities (UK, USA, Canada, and European Union).
Figure 9 Percentage of days covered by a morning patrol team (Morning), one night patrol team (PM1), two night patrol teams (PM2), three night patrol teams (PM3), and four night patrol teams (PM4) for the 2012 turtle season on Playa Norte, Costa Rica.

Green Turtle Total tracks

2321 green turtle (C. mydas) tracks were recorded in the 2012 season up to October 14th. Figure 10 shows the percentage of each record types recorded. 32% (n=735) of all emergences resulted in eggs laid (REC, REM and NST). Tag information was gathered for 8% (n=166) of all emergences where eggs were laid (REC and REM). 24% (n=554) of emergences were nests recorded without getting tag information on nesting females (NST). 67% (n=1560) of all emergences were false crawls (HLF). Just over 1% (n=24) of all emergences resulted in a turtle being poached (DEC and LIF).

From the total number of green turtle nests (n=735) patrol teams gathered tag information on 25% (n=181) (REC and REM) and were unable to gather tag information for 75% (n=554) of nesting turtles (Figure 11).
Figure 10 Percentage of green turtle (*Chelonia mydas*) record types from the turtle 2012 season on Playa Norte, Costa Rica.

Figure 11 Percentage of record types of nesting green turtles (*Chelonia mydas*) recorded in the 2012 green turtle season on Playa Norte, Costa Rica.

**Hawksbill Turtle Total Tracks**

Overall 92 hawksbill turtle (*E. imbricata*) tracks were recorded in the 2012 season. Figure 12 shows the percentage of each record types recorded. 34% (n=40) of all emergences resulted in clutch laying (REC, REM and NST). Tag information was gathered for 11% (n=10) of all emergences where eggs were laid (REC and REM). 33% (n=30) of emergences were nests recorded without getting tag information on nesting
females (NST). 54% (n=50) of all emergences did not result in egg laying. Just over 2% (n=2) of all emergences resulted in a turtle being poached (DEC and LIF).

![Pie chart showing percentages of hawksbill turtle record types for the 2012 turtle season on Playa Norte, Costa Rica.]

Figure 12 Percentage of hawksbill turtle (*Eretmochelys imbricata*) record types for the 2012 turtle season on Playa Norte, Costa Rica.

**Loggerhead Turtle Total Tracks**

Overall 36 loggerhead (*C. caretta*) turtle tracks were recorded in the 2012 season. Figure 13 shows the percentage of each record types recorded. Previously, very few loggerheads have been seen on Playa Norte. The lack of MINEAT permits for this species limited data collection and subsequently no tag information is available. 28% (n=10) of all emergences resulted in clutch laying (NST). 72% (n=26) of all emergences did not result in egg laying (HLF). No Loggerhead turtles were found to be deceased or lifted.
Figure 13 Percentage of loggerhead turtle \( \textit{(Caretta caretta)} \) record types for the 2012 turtle season on Playa Norte, Costa Rica.

**Green Turtle Vertical Nest Position**

The majority of green turtle \( \textit{(C. mydas)} \) nests were found in the border area with 69% \( (n=481) \). In addition, 25% \( (n=171) \) of nests were laid in the vegetation area and 6% \( (n=43) \) were laid in the open area (Figure 14).

Figure 14 Vertical nest position of green turtle \( \textit{(Chelonia mydas)} \) nests in the 2012 Season on Playa Norte, Costa Rica.
Hawksbill Turtle Vertical Nest Position

The majority of hawksbill turtle (*E. imbricata*) nests 64% (n=25), were found in the border area. 33% (n=13) of nests were laid in the vegetation and 3% (n=1) were laid in the open area (Figure 15).

![Hawksbill Turtle Nest Position](image)

Figure 15 Vertical nest position of hawksbill turtle (*Eretmochelys imbricata*) nests for the 2012 season on Playa Norte, Costa Rica.

Loggerhead Turtle Vertical Nest Position

The majority of loggerhead turtle (*C. caretta*) nests were found in the border area with 60% (n=6). In addition, 30% (n=3) of nests were laid in the border area and 10% (n=1) were laid in the open area (Figure 16).

![Loggerhead Turtle Nest Position](image)

Figure 16 Vertical nest position of loggerhead turtle (*Caretta caretta*) nests for the 2012 season on Playa Norte, Costa Rica.
Green Turtle Temporal Track Distribution

The first green turtle (*C. mydas*) track was recorded on May 3rd but tracks were not consistently seen until the week of June 10th. The peak of the season occurred the week of August 12th with a total of 124 nests and 446 tracks overall. The peak nesting day was August 17th with 41 nests and 154 total tracks. Green turtle tracks were still being recorded in low numbers after the cut-off date for analysis (as of Oct 16th, 2012). Figure 17 shows the temporal distribution nests laid during the 2012 green turtle season. Figure 18 shows the temporal distribution for all nesting activity for the 2012 green turtle season.

Figure 17 Temporal distribution of nests laid during the 2012 green turtle (*Chelonia mydas*) season on Playa Norte, Costa Rica.
Figure 18 Temporal distribution of all nesting activity for the 2012 green turtle (Chelonia mydas) season on Playa Norte, Costa Rica.

Hawksbill Turtle Temporal Track Distribution

The first hawksbill turtle (*E. imbricata*) track was recorded on April 13th. The peak of the season occurred the week of August 5th with a total of 5 nests and 10 tracks overall. Figure 19 shows the temporal distribution for all nesting activity for the 2012 hawksbill turtle season.

Figure 19 Temporal distribution of all nesting activity for the 2012 hawksbill turtle season on Playa Norte, Costa Rica.
Loggerhead Turtle Temporal Track Distribution

The first Loggerhead turtle (*C. caretta*) track was recorded on April 30th. Limited nesting makes it impossible to determine the peak of the nesting season. Figure 20 shows the temporal distribution for all nesting activity for the 2012 loggerhead turtle season. Unfortunately, loggerheads are very uncommon on Playa Norte and thus very few interns had seen their tracks before. It is possible tracks were misidentified.

![Figure 20 Temporal distribution of all nesting activity for the 2012 loggerhead turtle (*Caretta caretta*) season on Playa Norte, Costa Rica.](image)

Spatial Distribution of Green Turtle Nests

Figure 21 shows the spatial distribution of nests laid in the 2012 Green season. The highest number of nests (n=69) were laid between 0.25 and 0.38 miles. Green turtles nested throughout the transect but dips in nesting were seen between 0 and 0.25, 0.63 and 0.75, 1.25 and 1.50 miles, 1.88 and 2.00 miles, 2.25 and 2.50 miles, and between 2.88 and 3.13 miles.
Figure 21 Spatial distribution of green turtle (Chelonia mydas) nests laid during the 2012 season on Playa Norte, Costa Rica.

**Spatial Distribution of Hawksbill Turtle Tracks**

Figure 22 shows the spatial distribution for the 2012 hawksbill season. The highest number of nests were laid between 2.13 and 2.25 miles with 4 nests. Conversely, the majority of tracks were observed in the first half of the transect, with the highest number of tracks between 0.50 and 0.63 miles. No hawksbill turtle tracks were seen between 2.38 and 2.50 miles.

Figure 22 Spatial distribution of hawksbill turtle (Eretmochelys imbricata) nesting activity during the 2012 season on Playa Norte, Costa Rica
Spatial Distribution of Loggerhead Turtle Tracks

Figure 23 shows the spatial distribution for the 2012 loggerhead season. Nesting was limited so it is difficult to point out peak areas of nesting due to low sample size.

Figure 23 Spatial Distribution of loggerhead turtle (Caretta caretta) nesting activity during the 2012 season on Playa Norte, Costa Rica.

Green Turtles Encountered

Green turtles (C. mydas) were encountered on 299 instances during night patrol. From these 166 individuals were identified with tags (Figure 24). 32 green turtles were encountered more than once. 46% (n=77) of all individuals had tags or showed signs of previous tagging, whereas 54% (n=89) were likely tagged for the first time, having no signs of old tag holes or tag notches (Table 5). Of the individuals with signs of tagging 10% received two new 2012 Cano Palma tags, 9% had old Cano Palma tags from previous years (Table 6), 27% had STC (Sea Turtle Conservancy) tags (Table 4). 15% received one new tag this season, having arrived on the beach with only one tag (from either Cano Palma or the STC).

Figure 25 shows the time period at which turtles were encountered. All encounters occurred between 20:00 and 04:00, with most encounters, 14% (n=42), between 00:01 and 12:30. Turtles were encountered during all eight stages outlined in table 2. Turtles were encountered at all stages with no specific peak at any stage. Figure 26 shows the number of turtles encountered at each stage of nesting.
Figure 24 Identification and percentages of tags for the 2012 green turtle (Chelonia mydas) season on Playa Norte, Costa Rica.

Table 4 Identification and percentages of tags for the 2012 green turtle (Chelonia mydas) season on Playa Norte, Costa Rica.

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54% | 46% | 18% | 10% | 9% | 3% | 6% | 0% | Newly Tagged | 2012 Tagged w/OTH, OTN | STC Tags | Old CP Tags | Old CP Tag and 2012 Tag | Old CP Tag and STC Tag | STC Tag and 2012 Tag
Table 5 Newly tagged green turtles (*Chelonia mydas*) during the 2012 season on Playa Norte, Costa Rica.

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<td>CP1672</td>
<td>CP1804</td>
<td>CP1882</td>
<td>CP1883</td>
</tr>
<tr>
<td>127927</td>
<td>127928</td>
<td>CP1436</td>
<td>CP1438</td>
<td>CP1579</td>
<td>CP1580</td>
<td>CP1673</td>
<td>CP1671</td>
<td>CP1891</td>
<td>CP1893</td>
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<td>127930</td>
<td>127929</td>
<td>CP1464</td>
<td>CP1466</td>
<td>CP1582</td>
<td>CP1583</td>
<td>CP1676</td>
<td>CP1677</td>
<td>CP1896</td>
<td>CP1897</td>
</tr>
<tr>
<td>127931</td>
<td>127932</td>
<td>CP1471</td>
<td>CP1474</td>
<td>CP1589</td>
<td>CP1590</td>
<td>CP1678</td>
<td>CP1679</td>
<td>CP1900</td>
<td>127902</td>
</tr>
<tr>
<td>127933</td>
<td>127934</td>
<td>CP1507</td>
<td>CP1569</td>
<td>CP1592</td>
<td>CP1593</td>
<td>CP1696</td>
<td>CP1697</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 6: Newly tagged green turtles (*Chelonia mydas*) during the 2012 season on Playa Norte, Costa Rica.

<table>
<thead>
<tr>
<th>Right Tag</th>
<th>Left Tag</th>
<th>Year Tagged</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP0020</td>
<td>CP0021</td>
<td>2006</td>
</tr>
<tr>
<td>CP0085</td>
<td>CP0090</td>
<td>2006</td>
</tr>
<tr>
<td>CP1831</td>
<td>CP0184</td>
<td>2006</td>
</tr>
<tr>
<td>124621</td>
<td>CP0463</td>
<td>2007</td>
</tr>
<tr>
<td>CP0389</td>
<td>CP0390</td>
<td>2007</td>
</tr>
<tr>
<td>CP1612</td>
<td>CP0306</td>
<td>2007</td>
</tr>
<tr>
<td></td>
<td>CP1229</td>
<td>2010</td>
</tr>
<tr>
<td>CP0691</td>
<td>CP0692</td>
<td>2008</td>
</tr>
<tr>
<td>CP0848</td>
<td>127913</td>
<td>2008, New CP tag on Left</td>
</tr>
<tr>
<td>CP0888</td>
<td>127937</td>
<td>2008, New CP tag on Left</td>
</tr>
<tr>
<td>CP1153</td>
<td></td>
<td>2010</td>
</tr>
<tr>
<td>CP1166</td>
<td>CP1616</td>
<td>2010, New CP tag on Left</td>
</tr>
<tr>
<td>CP1268</td>
<td>CP1271</td>
<td>2010</td>
</tr>
<tr>
<td>CP1811</td>
<td>CP0112</td>
<td>2006, New CP tag on Right</td>
</tr>
<tr>
<td>127955</td>
<td>CP0594</td>
<td>2007, New CP tag on Right</td>
</tr>
<tr>
<td>CP0340</td>
<td>CP1554</td>
<td>2007, New CP tag on Left</td>
</tr>
</tbody>
</table>
Figure 25  **Green turtle** (*Chelonia mydas*) encounter times of turtles during the 2012 season on Playa Norte, Costa Rica.

Figure 26  Stage of encounter (see Table 2) for green turtles (*Chelonia mydas*) during the 2012 season on Playa Norte, Costa Rica

**Hawksbill Turtles Encountered**

Hawksbill turtles were encountered on 17 instances during night patrol. Of these encounters nine individuals were identified with tags (Figure 27). Two turtles were
encountered twice. Table 7 shows the six turtles who were tagged for the first time while Table 8 shows the three turtles who had been previously tagged.

![Pie chart](image)

**Figure 27** Breakdown of individualhawksbill turtles (*Eretmochelys imbricata*) identified with tags during the 2012 turtle season on Playa Norte, Costa Rica.

### Table 7 Hawksbill turtles (*Eretmochelys imbricata*) newly tagged during the 2012 turtle season on Playa Norte, Costa Rica.

<table>
<thead>
<tr>
<th>Tag Number</th>
<th>Tag Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>127994</td>
<td>127995</td>
</tr>
<tr>
<td>CP1587</td>
<td>CP1435</td>
</tr>
<tr>
<td>CP1510</td>
<td>CP1511</td>
</tr>
<tr>
<td>CP1553</td>
<td>CP1552</td>
</tr>
<tr>
<td>CP1620</td>
<td>CP1621</td>
</tr>
<tr>
<td>CP1625</td>
<td>CP1626</td>
</tr>
</tbody>
</table>

### Table 8 Tag numbers of hawksbill turtles (*Eretmochelys imbricata*) who were not tagged for the first time during the 2012 turtle season on Playa Norte, Costa Rica. One turtle tagged in 2012 and two carrying Sea Turtle Conservancy (STC) tags.

<table>
<thead>
<tr>
<th>Tag Number</th>
<th>Tag Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP1462</td>
<td>CP1507</td>
</tr>
<tr>
<td>110225</td>
<td>105816</td>
</tr>
<tr>
<td>113262</td>
<td>113276</td>
</tr>
</tbody>
</table>
**Green Turtle Biometrics and External Conditions**

Overall Curved Carapace Length (CCL\textsubscript{min} ) was measured for 167 turtles and Curved Carapace Width (CCW\textsubscript{max} ) was measured for 163 turtles. Mean CCL\textsubscript{min} was 105.6 cm (SD 4.77) with a maximum of 120.5 and minimum of 91.5. Mean CCW\textsubscript{max} was 94.9 cm (SD 4.67) with a maximum of 106.6 and minimum of 84.0.

**Hawksbill Turtle Biometrics and External Conditions**

Overall Curved Carapace Length (CCL\textsubscript{min} ) and Curved Carapace Width (CCW\textsubscript{max} ) was measured for 9 hawksbill turtles. Mean CCL\textsubscript{min} was 87.97 cm (SD 4.85) with a maximum of 97.27 and minimum of 84.07. Mean CCW\textsubscript{max} was 79.3 cm (SD 6.18) with a maximum of 90.43 and minimum of 71.90. Several hawksbill turtle encounters were covered in barnacles that may have affected measurements. No other external damage was noted.

**Green Turtle Excavations, Hatching and Emergence Success**

The initial analysis of data during this report includes all nests up to October 14\textsuperscript{th}. For the excavation and nest success data was used up to the end of the season.

There were a total of 324 green turtle nests excavated on Playa Norte in the 2012 season. The first successful excavation occurred on the August 13\textsuperscript{th} and the last December 31\textsuperscript{st}. Therefore only 42% of total know nests (n=771) showed signs of hatching and were excavated. From the excavated nests, 49 nests were dug up by dogs prior to the excavation and therefore with the uncertainty of the fate of these nests these were not included in Hatching Success or Emergence Success analysis.

When all nests were analysed together mean Hatching Success was 85.22%, and Emergence Success was 81.68%. A total of 84 triangulated nests where observers were present at the nesting event were successfully excavated. However, only 40 of these showed signs of hatching. When triangulated nests were analysed separately, mean Hatching Success was 78.54%, and mean Emergence Success 76.15% which is possibly a result of the smaller sample size.
Figure 28 Final excavation status of the green turtle triangulated nests (n=184) on Playa Norte, 2012

Figure 28 shows the final excavation status and poaching rates for green turtles on Playa Norte from triangulated nests (n=184). The number of nests with no excavation data was the highest category (51%). Natural & Hatched nests were the second highest category (30%) with Poached (14%) also constituting a large proportion of the overall excavations. Predated, Eroded and Natural & Unhatched all had relatively low outcomes after excavations were complete.

**Green Turtle Incubation Duration**

Using hatching dates from triangulated nests (n=40) the mean incubation duration was calculated. The maximum incubation duration for a green turtle nest from this data was 71 days and minimum 55 days. The mean incubation duration was 62.6 days after the nest was laid.

**Hawksbill Turtle Excavations, Hatching and Emergence Success**

There were a total of 15 hawksbill nests excavated on Playa Norte in the 2012 season. The first successful excavation occurred on July 27th and the last December 25th. Therefore, only 37.5% of the total known nests (n=40) showed signs of hatching and were excavated. From the excavated nests 5 were dug up by dogs prior to the excavation and therefore were not included in the analysis for Hatching or Emergence Success.
Three of the nine triangulated nests were successfully excavated so Hatching and Emergence Success analysis used all 15 excavated nests. Hatching success varied between 5.8% and 100%, with a mean of 87.3%. Emergence Success varied between 5.9% and 100%, with a mean of 86.9%.

![Excavation status of all hawksbill nests](image)

**Figure 29** Final excavation status of all hawksbill nests (n=44) from Playa Norte, 2012

Due to the relatively small sample size of excavated hawksbill nests (n=15) with triangulated nests (n=3) accounting for a small proportion of these Figure 29 shows the excavation status of all nests (n=44). Excavation data wasn’t collected for the largest proportion of nests (55.56%) with Natural & Hatched accounting for 22.22% percent of hawksbill nests. The number of nests that were Eroded or Dug up by dogs was the same (11.11%). Of the excavated nests Predated, Poached and Natural and Unhatched were all 0%. These figures would probably have been higher with more excavation data available for analysis.

**Hawksbill Turtle Incubation Duration,**

Using hatching dates for all of the excavated nests (n=15) the mean incubation duration was calculated. The small sample size of triangulated nests (n=3) excavated meant that to obtain a larger sample size to calculate this mean the NST data for excavated nests was used as well. The mean incubation duration was 63 days with a maximum of 90 days and minimum of 59 days.
Morning Census Nest Status

Morning census results for nests checked during the 2012 green season are shown in figure 28. 55% (n=395) of all nests checked were determined to be in natural condition, showing no sign of human interference. 39% (n=275) were classified as unknown, meaning they showed signs of human activity and possible poaching attempts but no conclusive poaching success. 6% (n=42) of nests were determined to have been poached in the first two days after being laid.

![Pie chart showing nest status](image)

Figure 30 Morning census nests status for green turtle (Chelonia mydas) nests laid during the 2012 season on Playa Norte, Costa Rica.

Overall, 42 nests were recorded as poached during morning census. All poached nests, as determined by morning census, occurred between June 24\textsuperscript{th} and September 29\textsuperscript{th}. Percentages of nests confirmed as poached during morning on a weekly basis were low (less than 20%) for the whole season. There was a decline in nests being determined as poached between July 22\textsuperscript{nd} and August 19\textsuperscript{th} (Figure 29). No trend in spatial distribution of poaching is evident from the green turtle data (Figure 30). Poaching occurred most often on Saturday and Sunday with 10% and 8.11% poached on these days respectively (Figure 31).
Figure 31 Percentage of green turtle (Chelonia mydas) nests recorded as poached on morning census for each week in the 2012 season on Playa Norte, Costa Rica.

Figure 32 Percentage of green turtle nests recorded as poached during morning census for each 1/8th (0.13) of a mile during the 2012 season on Playa Norte, Costa Rica.
Effects of Decoy Egg Chambers on Poaching

Upon limited analysis, decoy egg chambers appear to have a slight positive effect on the reduction of poaching. In morning census nest status 58% (n=36) of all nests with decoy egg chambers and 55% (n=431) of all nests without decoy egg chambers were recorded as natural. In addition, 3% (n=2) of all nests with decoy egg chambers were recorded as poached, whereas 7% (n=52) of all nests without decoy egg chambers were recorded as poached (Figure 32). Unfortunately morning census only provides a conservative number of poached nests as a nest is only recorded as poached if there are eggshells and a cavity present. Because of this, an examination of nest excavation status on both nests with decoy egg chambers and nests without was conducted. At the time of writing this report, most excavations had not been completed, thus only a truncated data set was available to work with. Sixteen nests with decoy egg chambers and twenty four nests without decoy egg chambers were used to examine nest excavation status. Comparing nests found to be in natural condition (natural and hatched, natural and unhatched, eroded or predated) and nests found to be poached (poached or partially poached), 81% (n=13) of nests with decoy egg chambers and 71% (n=17) without decoy egg chambers were found in natural condition. 19% (n=3) of all nests with decoy egg chambers and 29% (n=7) of all nests without decoy egg chambers were found to be poached (figure 33) (Not significant two-tailed P value equals 0.7110)

Although a larger sample size and further analysis is necessary, there is some evidence that digging decoy egg chambers has a positive effect. Readers must keep in mind that
many factors may influence the success of poaching activity and this is not a controlled study. Nonetheless, continuation of this activity may help to reduce poaching in 2013.

Figure 34 Morning census nest status (Natural, Unknown, Poached, Eroded and Predated) of nests with decoy egg chambers and nest with no decoy egg chamber for the 2012 turtle season on Playa Norte, Costa Rica.

Figure 35 Final excavation nest status (Natural Conditions vs. Poaching Successful) of nests with decoy egg chambers and nest with no decoy egg chamber for the 2012 turtle season on Playa Norte, Costa Rica.
Hawksbill Morning Census Nest Status

Morning census results for nests checked during the 2012 green season are shown in figure 34. 72% (n=28) of all nests checked were determined to be in natural condition, showing no sign of human interference. 23% (n=9) were classified as unknown, meaning they showed signs of human activity and possible poaching attempts but no conclusive poaching success. 5% (n=2) of nests were determined to have been poached in the first two days after being laid.

![Pie chart showing percentages of natural, poached, and unknown nests.]

Figure 36 Morning census nests status for hawksbill turtle (*Eretmochelys imbricata*) nests laid during the 2012 season on Playa Norte, Costa Rica.

Loggerhead Morning Census Nest Status

Morning census results for nests checked during the 2012 green season are shown in figure 35. 78% (n=7) of all nests checked were determined to be in natural condition, showing no sign of human interference. 22% (n=2) were classified as unknown, meaning they showed signs of human activity and possible poaching attempts but no conclusive poaching success. 0% (n=2) of nests were determined to have been poached in the first two days after being laid.
Poaching of Adult turtles

Twenty-eight turtles were either found deceased or lifted on Playa Norte in 2012. Twenty-six of these were green turtles and two were hawksbill turtles.

Ten turtles were found deceased on Playa Norte in 2012. Two deceased green turtles were found washed up on the beach, their front flippers tied to their rear flippers. Their carapaces showed evidence of harpooning. They appeared to have been in the sea for a few days. The rest were found on the beach butchered, often with their flippers and meat removed. Many had their throats slit, or head entirely removed.

Eighteen turtles were recorded as lifted on Playa Norte in 2012. Two of these were hawksbill turtles, and sixteen were green turtles. Patrol teams found turtle tracks going up the beach and no return tracks. Sometimes fake down tracks were made in an attempt to cover the crime. Other times patrols would find drag marks and many footprints.

One green turtle was found flipped upon morning census. The turtle was flipped back over and safely returned to the sea.

In addition, the project received information about boat-loads of turtles and turtle eggs being taken to Limon every 2-3 nights. The number of recorded deceased and lifted turtles is a minimum and there were likely more. An increased presence on the beach
may force some in-water poachers away when they are unable to take the easy route to the sea.

**Human Presence and Light Source**

Figure 36 shows the overall numbers of each human activity (white lights, red lights, locals, tourists and fires) observed throughout the turtle season. All activities except number of fires, increased through the season reaching a peak in July and then declining. This coincides with the regularly observed turtle season and subsequently the tourist season.

When looking at percentages of days each human activity was encountered for the marine turtle season, the most apparent trend is the number of locals encountered (Figure 37). This trend coincides with the trends of the green turtle season.

Overall, despite the illegality of being on the beach at night, 705 people were seen on night patrol, 332 were identified as probable locals and 373 as tourists.

Included in the number of mobile white lights is the security guard at Turtle Beach Lodge, who periodically shines a very bright white light throughout the night.
Figure 38 Total numbers of white lights, red lights, locals, tourists and fires encountered during night patrols for each month of the 2012 green turtle season on Playa Norte, Costa Rica.

Figure 39 Percentage of days each human survey activity was observed for each month of the 2012 turtle season on Playa Norte, Costa Rica.
Discussion:

Survey Effort:

Throughout the 2012 green turtle season survey efforts were consistent and there was considerably more coverage than previous years. Although beach coverage was good, numerous nesting females were still missed. The main two factors contributing to missed turtles are the length of the transect and the necessity to stay with a nesting turtle even after data collection is complete. Unfortunately, because of the amount of poaching of adult turtles, the protection of green turtle adults is more pressing then the need to collect information on more turtles. Nonetheless, COTER C’s marine turtle project is still young and there are a considerable amount of untagged turtles nesting on Playa Norte. Therefore in order to increase the amount of encountered turtles volunteer numbers need to increase. With more volunteers, and subsequently more people for teams, there can be more overlapping patrols on the beach, allowing for less missed turtles and a greater collection of biometric data.

Green Turtle Nesting Numbers:

Due to the cyclic nesting behavior of marine turtles it is expected to have variation in nesting numbers from year to year (Spotila 2004). With 2318 tracks and 735 nests in the season, 2012 seems to be a high year for green turtle nesting on Playa Norte (Table 9) (Stevens, A. 2010; Arroyo Arce and Jones 2009; Tsui et al 2008; Jackson et al. 2007; Chaparro et al 2006). However, as the project was only initiated in 2006 it is difficult to examine long term trends. Consistent efforts in following years are necessary to determine if population levels are changing. Nonetheless, this year’s data seems encouraging. Although the green turtle population on Playa Norte is small in comparison to the Tortuguero population encountered by The Sea Turtle Conservancy (Atkinson et al. 2010), given their endangered status it is important to protect as many green turtles as possible.
Table 9 Number of green turtle (Chelonia mydas) tracks and nests recorded for the seven years of data collection on Playa Norte, Costa Rica.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Tracks</th>
<th>Number of Nests</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>2321</td>
<td>735</td>
</tr>
<tr>
<td>2011</td>
<td>482</td>
<td>163</td>
</tr>
<tr>
<td>2010</td>
<td>2747</td>
<td>1154</td>
</tr>
<tr>
<td>2009</td>
<td>540</td>
<td>168</td>
</tr>
<tr>
<td>2008</td>
<td>1195</td>
<td>446</td>
</tr>
<tr>
<td>2007</td>
<td>1834</td>
<td>803</td>
</tr>
<tr>
<td>2006</td>
<td>914</td>
<td>347</td>
</tr>
</tbody>
</table>

**Hawksbill Turtle Nesting Numbers:**

There were more hawksbill tracks reported this year than any year since the turtle project was started at Cano Palma (Table 10) (Stevens, A. 2010; Arroyo Arce and Jones 2009; Tsui et al 2008; Jackson et al. 2007; Chaparro et al 2006). Sadly, 2-5 hawksbills have been found dead or reported as lifted for the past three years. Hawksbill turtles can nest 3-5 times in a season; therefore this year’s nesting population could be as small as eight females (Spotila 2004). Hawksbill sea turtles are critically endangered (ref iucn red list) and have been continuously declining within the Caribbean (Bjorndal et al 1993; Meylan 1999). Overall it is thought the Caribbean hawksbill population has declined 95% since pre-exploitation (Bjorndal and Jackson 2003). Therefore, it is essential even small populations, such as the one on Playa Norte, be vigilantly protected. Every effort should be made to encounter hawksbill turtles and disguise their nests.

Table 10 Number of hawksbill turtle (Eretmochelys imbricata) tracks, nests, and lifted and deceased turtles recorded for the seven years of data collection on Playa Norte, Costa Rica.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Tracks</th>
<th>Number of Nests</th>
<th>Lifted/deceased</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>92</td>
<td>40</td>
<td>2</td>
</tr>
<tr>
<td>2011</td>
<td>55</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>2010</td>
<td>35</td>
<td>16</td>
<td>3</td>
</tr>
<tr>
<td>2009</td>
<td>39</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>2008</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
</tr>
<tr>
<td>2007</td>
<td>32</td>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td>2006</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
</tr>
</tbody>
</table>
Loggerhead Turtle Nesting Numbers:

In the past six years, Loggerhead turtles have been barely mentioned in reports (Stevens, A. 2010; Arroyo Arce and Jones 2009; Tsui et al 2008; Jackson et al. 2007; Chaparro et al 2006). Tracks have always been very minimal. With 36 tracks observed in the 2012 season, it is clear that this species requires more attention. Acquisition of MINAET permits would allow patrol teams to read and apply tags to collect data on where loggerheads may be originating from.

Green Turtle Temporal and Spatial Distribution

The peak of the 2012 green turtle season was seen the week of August 12\textsuperscript{th} to 18\textsuperscript{th}. During the history of the project this peak has varied between late July to the 1\textsuperscript{st} week of September (Table 11) (Stevens, A. 2010; Arroyo Arce and Jones 2009; Tsui et al 2008; Jackson et al. 2007; Chaparro et al 2006). Because of this variation, it is difficult to prepare for the peak by amassing volunteers. This year a large group of volunteers left the station around August 15\textsuperscript{th}, leaving a much smaller amount of people available for the peak. In order to avoid this in the future, volunteer recruitment for the marine turtle project should be focused on the end of July until the beginning of September.

In addition, Green turtles continued to be consistently seen throughout September and even into October. In previous years, night patrols have ended in October and even as early as September. Due to significant numbers of turtle sightings during these months, night patrols should continue during this time.

Table 11 Peak nesting times for green turtles (Chelonia mydas) for the seven years of data collection on Playa Norte, Costa Rica.

<table>
<thead>
<tr>
<th>Year</th>
<th>Peak</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>August 12\textsuperscript{th} to 18\textsuperscript{th}</td>
</tr>
<tr>
<td>2011</td>
<td>Last week of July</td>
</tr>
<tr>
<td>2010</td>
<td>August 30\textsuperscript{th} and Sept 4\textsuperscript{th}</td>
</tr>
<tr>
<td>2009</td>
<td>August 16\textsuperscript{th} to 29\textsuperscript{th}</td>
</tr>
<tr>
<td>2008</td>
<td>Peak day August 31\textsuperscript{st}</td>
</tr>
<tr>
<td>2007</td>
<td>September 2\textsuperscript{nd} to 8\textsuperscript{th}</td>
</tr>
<tr>
<td>2006</td>
<td>September</td>
</tr>
</tbody>
</table>
Green turtle nests were found throughout the entire transect with a peak between 0.25 and 0.38 of a mile. Dips in nesting seem to occur near hotels and houses that have large, bright lights (between 0.13 and 0.25, 0.63 and 0.75, 1.25 and 1.50 miles, between 2.25 and 2.50 miles). This may indicate that green turtles are avoiding nesting in this area. Many studies have found that marine turtles avoid white lights when nesting (Witherington 1992). In order to improve these areas for nesting, hotels and home owners should be approached concerning what they could do to reduce the amount beachfront lighting.

**Hawksbill and Loggerhead Turtle Temporal and Spatial Distribution**

Both hawksbill and loggerhead turtles nested sporadically throughout the entire marine turtle season in 2012. Because of low numbers it is difficult to see trends in spatial or temporal distribution. Hawksbill turtles emerged more often in the first half of the transect but seem to have eventually nested sporadically throughout the entire transect. Continued monitoring is necessary for both species to begin to see trends.

**Green and Hawksbill Turtle Encounters**

With 54% of green turtles newly tagged and 67% of hawksbill turtles newly tagged, a high proportion of turtles nesting on Playa Norte have never been tagged. Patrol teams in coming years should strive to tag and identify more individuals.

27% of identified green turtles and 22% of identified hawksbill turtles carried Sea Turtle Conservancy tags. This indicates that these turtles have a nesting range large enough to encompass both organizations transects. It is therefore important that this information should continue to be shared between the STC and COTERC’s marine turtle project.

All green turtle encounters occurred between eight in the evening and four in the morning. In order to protect nesting turtles arriving on Playa Norte, every effort should be made to cover the majority of these hours. In particular, patrols should focus on peak hours between 10 o’clock and 2 o’clock.

Due to the poaching of adult turtles that occurs on Playa Norte, all encounters are very important (Stevens, A. 2010; Arroyo Arce and Jones 2009; Tsui et al 2008; Jackson et al. 2007; Chaparro et al 2006). This is particularly important for hawksbill turtles because of their already very small population.
Nest Status and Poaching Activity:

The status of nests recorded as poached for all species, as determined by morning census, was 6%. This estimation is well below poaching rates for nests in previous years (Table 12). The reason for this value being so low given that poachers were seen on an almost nightly basis throughout the season was the strict criteria that were followed to classify a nest as poached. Unless egg shells were seen at a nest it was recorded as Unknown status, even if other signs such as an empty egg chamber, stick holes, footprints and disturbed sand were recorded. The percentage of nests of Unknown status during morning patrols was 39%. When the confirmed Poached and Unknown statuses are combined it results in 45% of nests that were disturbed by humans and potentially

Table 12 Percentage of poached nests determined by morning census and by excavation for green turtles (Chelonia mydas) for the seven years of data collection on Playa Norte, Costa Rica.

<table>
<thead>
<tr>
<th>Year</th>
<th>Percentage Poached by Morning</th>
<th>Percentage Poached by excavation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>2011</td>
<td>25</td>
<td>56</td>
</tr>
<tr>
<td>2010</td>
<td>10</td>
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<td>2009</td>
<td>24</td>
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<td>2008</td>
<td>12</td>
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<td>2007</td>
<td>22</td>
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<td>2006</td>
<td>55</td>
<td>64</td>
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poached during the first two days after the eggs were laid. This value is probably slightly higher than the true poaching rate on Playa Norte but is likely to be closer than the 6% quoted. Further support for a higher poaching rate comes from the 58% of green nests (n=446) where no signs of hatching were observed. A proportion of these would have been failed nests, eroded or predated but poaching would also have accounted for many of these nests. A conservative estimate of poaching of eggs on Playa Norte would be between 25% and 35% based on these figures. Therefore, every effort should be made in the coming years to have multiple night patrol teams and good beach coverage.

Anecdotal evidence indicates that poachers are non-confrontational and avoid poaching attempts when patrol teams are present. Nonetheless, patrol teams encountered poachers and poaching groups many times. Some were not very discrete, waving to teams while carrying bags of turtle eggs. Patrol teams have no ability to enforce laws and therefore could do nothing in these situations. It is expected that MINAET’s presence and enforcement on Playa Norte could have a very positive effect on reducing poaching. The majority of nest poaching occurred on weekends between June 24th and
September 29th. These are times patrol teams and MINAET should focus their efforts in order to reduce poaching.

Adult turtle poaching on Playa Norte is extremely worrisome considering the importance of nesting females for the overall population (Crouse 1999). This is particularly true for hawksbill and loggerhead sea turtles, as noted previously, who have a very small population on Playa Norte. In these situations increase of enforcement by MINAET is particularly necessary. In addition, protocols should continue with patrol teams staying with turtles until they leave the beach.

**Excavation Status and Success**

In the 2012 nesting season a large amount of effort was put into monitoring the emergence of hatchlings from both triangulated (REC, REM) and non-triangulated nests (NST). With green turtles nesting in relatively high abundance compared to previous years (n=771) this meant that resources were stretched trying to locate nests using GPS coordinates for those nests not triangulated (n=574). In total 324 nests were excavated from both triangulated and non-triangulated green nests. The absence of 58% of excavation data for green turtles is considerable and human resources may need to be re-directed in future years to ensure a higher percentage of nests are located. This could be achieved by only trying to excavate triangulated nests and ensuring that they are all found.

The 84 triangulated green nests that were excavated represented only 46% of the total possible excavations for nests (n=184) where the specific location should have been known. The loss of data from 54% of was due to combination of factors. High poaching rates removed eggs and often flagging tape in the ground was not recovered to confirm poached status. Flagging tape around vegetation to mark the nests was also removed by locals, often when it occurred outside their properties. In this situation inexperienced volunteers were often not able to locate nests when one or two pieces of tape were missing. Far more attention needs to be paid to these nests in the future as they represent the only source of reliable nest information with regards to clutch size, lay date and orientation. Where excavation data was available the percentage of Natural and Hatched nests was 30%. From this figure the mean Hatching Success (78.54%) and Emergence Success (76.15%) was calculated. These success rates are relatively high and indicate that when nests are not affected by human interference stand a good chance of survival.

The percentage of poached nests estimated from excavated nests was 14%. Poaching activity was observed on Playa Norte on an almost nightly basis and this figure is the absolute minimum given the high proportion of nests with no excavation data. Again, concentrating on triangulated nests would help gain better data on poaching rates.
Due to the small sample size of Hawksbill nests (n=44) and lack of excavation data from triangulated nests all excavations were included in the nest status and success for this species. With 59% of hawksbill nests not having excavation information it is again difficult to draw any strong conclusions with so much data absent from the analysis. With 30% of hawksbill nests Natural & Hatched and mean Hatching success (87.3%) and Emergence Success (86.9%) it would appear that when not disturbed, like the green turtles, hawksbill nests were relatively successful. The numbers of hawksbill and loggerhead turtles observed during 2012 indicate a small nesting population that needs to be better protected by conservation managers and policy makers.

**Incubation Duration**

The mean incubation duration for green turtles (66 days) and Hawksbill (63 days) is comparable to previous year’s reports. It also justifies the protocol of monitoring nests after 60 days from the lay date has passed.

**Human Presence and Light Source:**

Despite the illegality of being on the beach at night, both tourists and locals are consistently seen on Playa Norte during night patrols. Tourists may inadvertently interfere with turtles’ natural nesting behavior when patrol teams are not present to prevent such interactions. Although it is impossible for us to keep tourists off the beach, educational presentations may provide them with the knowledge necessary to avoid disturbing a nesting turtle. Educational presentations at local hotels, lodges and school should be increased to help prevent negative interactions with tourists, but these presentations need to be structured in a way that does not give the hotel or the tourists the idea that we support or condone their presence on the beach.

In addition, many of the people observed on patrols, particularly during the peak of the green season, were groups of men carrying bags. Many of these were observed following turtle tracks up to investigate nests, only leaving when they realized patrol teams were present. Poaching on Playa Norte is common and increased enforcement by MINAET would likely reduce the number of nests poached and turtles killed each year.
References


Stevens, A. 2010; Arroyo Arce and Jones 2009; Tsui et al 2008; Jackson et al. 2007; Chaparro et al 2006